U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **SD PFH 17-1(6) HILL CITY - LEAD**
PAVEMENT RECOMMENDATIONS

Date: 12-08-2008

From: Tracy D. Piparato, Highway Engineer
Steve Deppmeier, Pavements Engineer

To: Mark Meng, Project Manager
Tony Galardi, Lead Designer

The project consists of four sites; Site 1, Site 2, Site 3, and Site 4. All four sites have an existing bituminous surface. The project will be 4R with a 20-year design life pavement structure, beginning at Station 31+69 and ending at Station 137+00. Although the roadway will be reconstructed at the spot repair sites, a pavement design life of 25 years (per PDDM 11.2.1.1) will not be used since portions of the roadway located between the spot repair sites will not be rebuilt. The combined distance for all four sites is approximately 1.3 miles. Site 1 begins at Station 31+69 and ends at Station 47+35. Throughout Site 1, the bituminous surfacing averaged 5.3 inches in thickness while the base course type material averaged 6.8 inches. The subgrade consisted predominantly of A-4 soils. The R-Value of the subgrade for this site was 29.

Site 2 begins at Station 100+00 and ends at Station 120+00. Throughout Site 2, the bituminous surfacing averaged 5.5 inches while the base course type material averaged 6.5 inches. The subgrade consisted of A-4, A-1-b, and A-2-4 soils. The R-Value of the subgrade for this site was 23.

Site 3 begins at Station 47+35 and ends at Station 64+81. Throughout Site 3, the bituminous surfacing averaged 7.8 inches while the base course type material averaged 3.5 inches. This section of roadway was more distressed with a large patch area caused from a failing dry-stack rock retaining wall adjacent to the roadway. The subgrade consisted mainly of A-4 and A-2-4 soils. The R-Value of the subgrade for this site was 19. The existing dry-stack rock retaining wall will be reconstructed using an MSE wall resulting in the reconstruction of the road embankment as well.

Site 4 begins at Station 120+00 and ends at Station 137+00. Throughout Site 4, the bituminous surfacing averaged 7.6 inches while the base course type material averaged 4.8 inches. This section of roadway has a large patch area caused from a failing dry-stack rock retaining wall adjacent to the roadway. The subgrade consisted predominantly of A-6 soils. Similar to Site 3,

the existing dry-stack rock retaining wall will be reconstructed with an MSE wall resulting in the reconstruction of the road embankment as well.

Two-way ADT, supplied by Pennington County Highway Department, was approximately 2380 with 5% of vehicles larger than a passenger vehicle. Due to the large number of logging trucks and heavy construction/mining trucks utilizing this route, a value of 1,246,700 ESALs was used to calculate the structural number (SN). The design subgrade soil resilient modulus was estimated to be an average of 5700 psi for a design R-Value of 24 across the entire project. The required SN is 3.64. The following pavement structural sections were evaluated:

Option 1: Recommended
5 inches HACP
12 inches Base Course
SN = 3.68
Cost Estimate = $1,093,798 per mile for 28 foot width, paving items only
(See attached DARWin Pavement Calculations)

Option 2:
6 inches HACP
10 inches Base Course
SN = 3.80
Cost Estimate = $1,116,487 per mile for 28 foot width, paving items only
(See attached DARWin Pavement Calculations)

The above two options are 20-year designs. The cost estimates are relative costs pertaining to HACP and base course items only.

Since the 4 sites may not be included in one contract, the following bid items are recommended:

PAVEMENT MATERIALS

- HACP should be Bid Item 40301-0000, Hot Asphalt Concrete Pavement. The unit weight can be estimated at 145.2 lb/ft^3.
- The asphalt cement should be PG 58-34. Quantity can be estimated at 6.0% by weight of mix.
- The 5 inch depth HACP shall be placed in two equal lifts.
- Tack Coat is required between lifts. The emulsion type should be CSS-1, CSS-1h, SS-1, or SS-1h. The application rate for estimating is 0.10 gal/yd^2.
- A Fog Seal, Bid Item 409 should be applied to the final surface. The emulsion type should be CSS-1, CSS-1h, SS-1, or SS-1h. The application rate for estimating is 0.10 gal/yd^2.
- Base Course should be Bid Item 30101-0000, Aggregate Base, paid by the ton. The unit weight can be estimated at 139 lb/ft^3.
- Bid Item 41101-0000, Prime Coat paid by the ton, should be applied to the base course prior to paving. The application rate for estimating is 0.33 gal/yd^2.
- Blotter, Item 411 should be included in the contract. For estimating, the application rate is 14.75 lb/yd^2.

CC: Mike Voth, Pavements FDL
Dave Balding, COE
Mike Peabody, Materials Engineer
Richard Duval, QA Engineer
Matt DeMarco, Lead Geotechnical Engineer

Attachment: DARWin Pavement Calculations
Cost Estimate Worksheet
LTPPBind

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

SD PFH 17-1(6) HILL CITY - LEAD
OVERALL PROJECT
OPTION 1

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,246,070
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	75 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,700 psi
Stage Construction	1
Calculated Design Structural Number	3.64 in

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	2,380
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	60 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
2	95	2	0.0004	0	4,717
6	1	2	1.2	0	148,962
9	3	2	2.2	0	819,293
10	1	2	2.2	0	273,098
Total	100	-	-	-	1,246,070

Growth	Simple
Total Calculated Cumulative ESALs	1,246,070

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HACP	0.4	1	5	-	2.00
2	BASE COURSE	0.14	1	12	-	1.68
Total	-	-	-	17.00	-	3.68

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

SD PFH 17-1(6) HILL CITY - LEAD
OVERALL PROJECT
OPTION 2

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,246,070
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	75 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,700 psi
Stage Construction	1
Calculated Design Structural Number	3.64 in

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	2,380
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	60 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
2	95	2	0.0004	0	4,717
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Total	100	-	-	-	1,246,070

Growth	Simple
Total Calculated Cumulative ESALs	1,246,070

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HACP	0.4	1	6	-	2.40
2	BASE COURSE	0.14	1	10	-	1.40
Total	-	-	-	16.00	-	3.80

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Paved width = 28 ft.
Route = 1.33 miles

Option Items	inches convert to feet				length of route (ft)		width (ft)		unit weight		lbs to tons		tons		$ / ton		
10" Base Imported	10	x	0.0833	x	7025	x	35.33	x	139	/	2000	=	14369	x $	40	=	$574,751
12" Base Imported	12	x	0.0833	x	7025	x	35.33	x	139	/	2000	=	17243	x $	40	=	$689,701
5" HACP	5	x	0.0833	x	7025	x	28	x	145.2	/	2000	=	5948	x $	120	=	$713,735
Lime	1%												59	x $	200	=	$11,896
6" HACP	6	x	0.0833	x	7025	x	28	x	145.2	/	2000	=	7137	x $	120	=	$856,482
Lime	1%												71	x $	200	=	$14,275

	square feet convert to square yards							application rate		density		tons		$ / ton		
Tack	7025	x	28	x	0.1111	=	21,853	x	0.1	/	241	=	9	x $	600	=	$5,441
Fog	7025	x	28	x	0.1111	=	21,853	x	0.1	/	241	=	9	x $	600	=	$5,441
Prime	7025	x	28	x	0.1111	=	21,853	x	0.33	/	253	=	29	x $	775	=	$22,091
Blotter	7025	x	28	x	0.1111	=	21,853	x	14.75	/	2000	=	161	x $	40	=	$6,447
															SUBTOTAL		$39,419

Option #1 5" HACP + 12" Base Imported

$1,454,751 **total cost**

$1,093,798 **per mile**

Option #2 6" HACP + 10" Base Imported

$1,484,927 **total cost**

$1,116,487 **per mile**

Five Closest Weather Stations For Latitude/Longitude= 44.006/103.324
Report Date: 12/4/2008
(LTPPBind V3.0 Alpha)

SD 17-1(6) - HILL CITY - LEAD

General	A=14 km	B=14 km	C=18 km	D=20 km	E=34 km
Station ID	SD6427	SD6947	SD5870	SD6937	SD2231
County/District	pennington	pennington	pennington	pennington	pennington
Weather Station	pactola dam	rapid city	mt rushmore nat	rapid city	deerfield 3 se
Elevation, m	1337	977	1466	896	1716
Latitude, Longitude	44.07 ,103.48	44.12 ,103.28	43.88 ,103.45	44.05 ,103.07	44 ,103.78
Last Year Data Available	1997	1997	1997	1997	1997

Air Temperature	Mean (Std, N)	Mean (Std, N)	Mean (Std, N)	Mean (Std, N)	Mean (Std, N)
High Temperature	30.6 (21,32)	34.2 (21,33)	31.8 (23,35)	34.8 (21,35)	28.5 (19,16)
Low Temperature	-30.9 (32,31)	-28 (32,33)	-27.3 (39,35)	-28.6 (31,35)	-36.1 (42,16)
Low Temperature Drop	32.6 (45,31)	31.4 (39,33)	28.5 (42,35)	30.7 (42,35)	30.2 (36,16)
Degree-Days > 10C	2006 (215,32)	2633 (260,33)	2161 (248,35)	2653 (221,35)	1785 (191,16)

PG	High Low Rel.	High Low Rel.	High Low Rel.	High Low Rel.	High Low Rel.
Pavement Temperature, C	47.4 -22.8	53.4 -20.8	49.0 -20.2	53.6 -21.2	45.1 -26.5
50% Reliability PG	52-28 (98,95)	58-22 (98,66)	52-22 (98,70)	58-22 (98,61)	46-28 (74,65)
>50% Reliability PG	52-34 (98,98)	58-28 (98,98)	52-28 (98,98)	58-28 (98,98)	46-34 (74,97)
=					52-34 (98,97)
=					52-40 (98,98)
=					
=					